Treatment of gummy smile using botulinum toxin

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Treatment of gummy smile using botulinum toxin

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This certifies that the masters thesis

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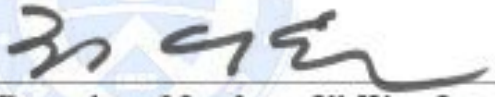

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지금까지 제 옆에서 있어 주신 모든 분들께 사랑과 감사의 마음을 보내며 이 글을 마칩니다.

2015 년 12 월

명양호 드림

TABLE OF CONTENTS

TABLE OF CONTENTS····· i

LIST OF FIGURE AND TABLES ····· ii

ABSTRACT····· iii

I. INTRODUCTION····· 1

II. SUBJECTS AND METHOD ····· 3

III. RESULTS ····· 5

IV. DISCUSSION····· 13

V. CONCLUSION····· 22

REFERENCES ····· 23

ABSTRACT (in Korean) ····· 26

LIST OF FIGURE

Figure 1. Stepwise approach to select the included literature …… 4
Figure 2. Main muscle involved in gingival exposure ……13

LIST OF TABLES

Table 1. Summary of composition of patient in the treatment of excessive gingival display…… 7
Table 2. Summary of measuring method in the treatment of excessive gingival display …… 8
Table 3. Summary of BoNT in the treatment of excessive gingival display …… 9
Table 4. Summary of BoNT injection technique in the treatment of excessive display……10
Table 5. Summary of outcomes in the treatment of excessive gingival display …… 11

Abstract

Treatment of gummy smile using botulinum toxin

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Excessive gingival exposure refers to gingival exposure of more than 2mm when smiling and it is considered as non-aesthetical. Causes of excessive gingival exposure onset include delayed eruption of tooth, vertical maxillary excess, hypermobile upper lip, and short upper lip. Either prosthodontic, corrective, or surgical treatment can be used depending on the cause of its onset. Recently, the treatment method of excessive gingival exposure using botulinum toxin (BoNT) was introduced as non-surgical method. Since treatment method is yet to be standardized, there is controversy over the treatment method or effect.

Accordingly, the purpose of this study is to examine the role of BoNT as the treatment method for excessive gingival exposure and research guidelines for excessive gingival exposure research using BoNT in the future through literature review.

Online literature review was conducted via Pubmed, Scopus, and Web of science on April 1st, 2015. Keywords used for search were gummy smile, gingival exposure, or combination of gingival display with either botox, botulinum, onabotulinumtoxinA, or abobotulinumtoxinA. Thirty three literatures were searched as a result and 10 articles were used in this study excluding the 23 literatures that did not meet the inclusion criteria.

As a result of literature review, it was revealed that BoNT treatment for excessive gingival exposure is reversible and effective treatment and side effects followed by BoNT injection was minimal and temporary. Also, the satisfaction of patients toward the treatment is high and treatment effect lasts for at least 12 weeks. Since there are several limitations in this research, clinically significant result may be acquired when well designed randomized controlled trials are conducted in the future.

Keywords: gummy smile, excessive gingival exposure, botulinum toxin(BoNT)

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I. INTRODUCTION

A person's beautiful smile is probably the most pleasing and meaningful facial expression. Beautiful smile should be symmetric and display less than 2~3mm of the gum. Excessive gingival exposure, which is commonly described as "gummy smile", is a frequent cause of patient's dissatisfaction, and more spotlight has been shed upon it recently in the dental field. Gummy smile may result from delayed eruption, vertical maxillary excess (VME), hypermobile upper lip (HUL), or a short upper lip (Humayun et al., 2010). Various treatment modalities have been tried till date for the treatment of gummy smile. Delayed eruption is treated by esthetic crown lengthening (Rosenblatt and Simon, 2006). In case of VME, gummy smile is often treated alone by orthognathic surgery or a multidisciplinary approach with either orthognathic surgery, orthodontic treatment, periodontal treatment, or restorative dentistry is required (Garber

and Salama, 1996). In case of short upper lip, it can be treated by lip lengthening, which has also been performed in conjunction with rhinoplasty (De Souza Pinto, 2003; Harpreet et al., 2014).

In case of HUL, various treatment approaches have been used, with highly variable outcomes. Botulinum toxin(BoNT) type A (Polo,2005; Mazzuco and Hexsel, 2010), lip repositioning (Rubinstein and Kostianovsky, 1973; Rosenblatt and Simon, 2006; Simon et al., 2007), detachment of lip muscle (Litton and Fournier, 1979) and lip repositioning combined with gingivectomy (Gabric et al., 2014) are the reported treatment approaches.

Spotlight has been shed upon BoNT injection among such various treatment methods of gummy smile because it is a simple, non-invasive, and reversible treatment with less side effects. Polo (2005) has introduced for the first time the method to inject BoNT to muscle around the lip. BoNT is produced by the anaerobic bacterium Clostridium botulinum. There are 8 different serotypes of BoNT. Type A is the most potent and the most commonly used clinically. BoNT weakens skeletal muscles by cleaving the synaptosome-associated protein SNAP-25, thus blocking the release of acetylcholine from the motoneuron and enabling the repolarization of the postsynaptic terminal. As a result, the muscular contraction is blocked.

Although gummy smile treatment method using BoNT has advantages of being safe, reliable, and reversible, it was introduced relatively recently thus there are limitations in that there is not many literatures and research methods and treatment methods of each research differ vastly. Since there is no standardized treatment method yet, there still is a controversy over the treatment method or effect.

Accordingly, the purpose of this study is to provide a summary of treatment method and road map for studies on gummy smile treatment using BoNT in the future through literature review on gummy smile treatment using BoNT.

II. SUBJECTS AND METHOD

This review included all studies related to the treatment of gummy smile with BoNT injection until March 2015. Online literature review was conducted via Pubmed, Scopus, and Web of science on April 1st of 2015. Twelve keywords were used. Twelve keywords were combination of gummy smile OR gingival exposure OR gingival display AND botox OR botulinum OR onabotulinumtoxinA OR abobotulinumtoxinA. Thorough analysis was conducted for searched literatures. Exclusion criteria included the cases that do not concern gummy smile treatment, propose gummy smile treatment case reports, prescribe the BoNT, and cases that use treatment method other than BoNT treatment.

The selected literatures were analyzed by the following items- gender and age of patients, measuring site and measuring method of gummy smile, product and preparation of botulinum toxin used in the treatment, target muscle and injection point used in the treatment, pre-treatment gingival exposure, post-treatment gingival exposure, improvement percentage, satisfaction evaluation, short term adverse events, treatment longevity.

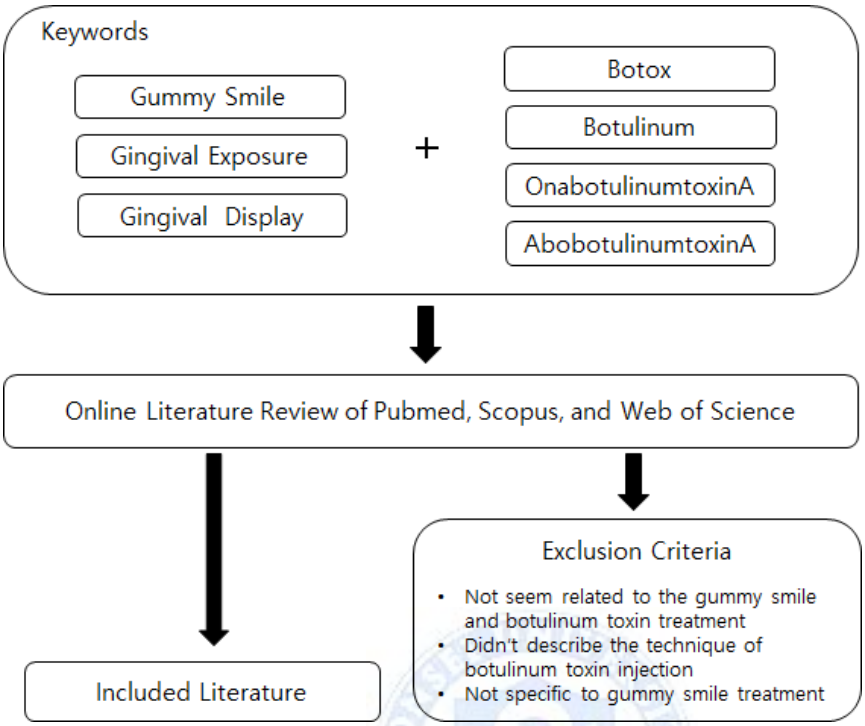

Figure 1. Stepwise approach to select the included literature

III. RESULTS

Thirty three papers were acquired as a result of online literature search via Pubmed, Scopus, and Web of science. Twenty three papers among them were excluded as it fell under the exclusion criteria. Four papers described other treatment methods (surgery or laser) for gummy smile and 19 papers were either irrelevant to gummy smile treatment, not specific to gummy smile treatment, and give no description on BoNT injection and its effect. Therefore, 10 papers were used for this review.

Composition of patients

Number of subjects who received BoNT injection treatment in 10 papers was 131 in total. When disregarding the 4 papers which do not present either sex or age of the treatment subject, most of treatment subject was female with wide range of age distribution from 15-48. Eight papers have described the treatment subject selection criteria for BoNT injection treatment and 7 papers considered pure HUL patients as the subject excluding patients with VME and delayed passive eruption of teeth. One literature conducted treatment with patient which require surgical treatment as its subject (Table 1).

Measurement of gummy smile

In regards to the measurement parts for quantity of gummy smile, it was mostly measured at the central incisor. It sometimes was measured at the canine teeth or the first premolar. As a method to measure the quantity of gummy smile, 7 literatures conducted indirect measurement with the use of photograph or video equipment and 1 literature conducted repetitive measurement by putting ruler directly to the face. Also, in order to acquire

maximal smile during the process of measuring the quantity of gummy smile, 2 papers described that funny joke or statement was used and 1 paper described that it was measured upon the emergence of expression of eye such as squint (Table 2).

Botulinum toxin

Nine studies used onabotulinumtoxinA (Botox, Allergan, Irvine, California) with concentration raging from 2U/0.1mL to 5U/0.1mL. One study used abobotolinumtoxinA (Dysport, Ipsen Biopharm Limited, Wrexham, United Kingdom) with a concentration of 25 U/0.1mL. The total dose of BoNT injected per side ranged from 1.95 to 6.25 U and from 2.5 to 7.5 U for onabotulinumtoxinA and abobotulinumtoxinA, respectively (Table 3).

Injection technique

There were 1 to 3 injection points per each side and levator labii superioris alaque nasi (LLSAN) was presented to be muscle targeted by injection in 9 papers excluding 1 paper which identified gummy smile as anterior, posterior, mixed and asymmetric. Other muscles targeted by injection are levator labii superioris (LLS), zygomaticus major (ZM), zygomaticus minor (Zmi), and depressor setpi nasi (DSN). In order to determine the location of injection, 3 papers used electromyography, 5 used the distance from particular landmark, and 2 pinpointed the location by touching the contracted muscle during smile to ensure precise muscle location before injection (Table 4).

Treatment outcomes

The degree of improvement in gingival exposure before and after the treatment observed to be varying from 60.1 to 98% in 6 papers. The evaluation on satisfaction after treatment was conducted in 4 papers and presented high

degree of satisfaction but short-term adverse events were proposed in 3 papers. The treatment longevity was reported in Table 5.

Table 1. Summary of composition of patient in the treatment of excessive gingival display

Study	Number of patients	Gender ratio (woman : man)	Age(range)	Selection of patients
Polo, 2005	5	Women	(16~23)	Hyperfunctional upper lip
Kim et al., 2006	5	Women	29.8(27~36)	None
Polo, 2008	30	(29:1)	24.4(15~41)	Hyperfunctional upper lip
Hwang et al., 2009	1	Woman	25	Hyperfunctional upper lip
	1	Woman	18	Asymmetric smile
Gracco and Tracey, 2010	3	Women	None	Surgical treatment needed patient
Mazzuco and Hexsel, 2010	3	None	None	The patients had visited dentists and reported not having received any indication for surgical treatment and claimed they were unwilling to undergo such a treatment modality.
	7	None	None	
	3	None	None	
	3	None	None	
Sucupira and Abramovitz, 2012	52	None	None	None
Dinker et al., 2013	1	Woman	23	Hyperfunctional upper lip
Singh et al., 2014	3	Woman	None	Hyperfunctional upper lip
Suber et al., 2014	14	(13:1)	34y(23~48)	Cuspid smile patient
Total	131			

Table 2. Summary of measuring method in the treatment of excessive gingival display

Study	Measuring method	Measuring site		Evaluation or inducement of maximum smile
Polo, 2005	Photograph	Central incisor		None
Kim et al., 2006	None	None		None
Polo, 2008	Photograph, video recording	Central incisor		Extremely funny joke
Hwang et al., 2009	None	None		None
Gracco and Tracey, 2010	Video recording	Central incisor		None
Mazzuco and Hexsel, 2010	Photograph	Anterior GS	Central incisor	None
		Posterior GS	First premolar	
		Mixed GS	Central incisor	
		Asymmetric GS	First premolar	
Sucupira and Abramovitz, 2012	Photograph	None		None
Dinker et al., 2013	Photograph	Central incisor		Expression of eye
Singh et al., 2014	Photograph	Central incisor		None
Suber et al., 2014	Standardized measuring tape	Right and Left central incisor, Right and Left canine		Funny joke or statement

GS, gummy smile

Table 3. Summary of BoNT in the treatment of excessive gingival display

Study	Product and preparation	Units per side(U)	
Polo, 2005	Botox(OnabotulinumtoxinA) 2.5U/0.1ml	5~6.25U	
Kim et al., 2006	Botox(OnabotulinumtoxinA) None	5U	
Polo, 2008	Botox(OnabotulinumtoxinA) 2.5U/0.1ml	5U	
Hwang et al., 2009	Botox(OnabotulinumtoxinA) 5.0U/0.1ml	GS	3U
		Asymmetric GS	Unilateral injection
Gracco and Tracey, 2010	Botox(OnabotulinumtoxinA) 2.5U/0.1ml	2.5U	
Mazzuco and Hexsel, 2010	Dysport(AbobotulinumtoxinA) 25U/0.1ml	Anterior GS	2.5 or 5U
		Posterior GS	5 U
		Mixed GS	6.25U or 7.5U
		Asymmetric GS	5U onside and 2.5U on the other
Sucupira and Abramovitz, 2012	Botox(OnabotulinumtoxinA) 3.1U/0.1mL	1.95U	
Dinker et al., 2013	Botox(OnabotulinumtoxinA) 2.5U/0.1mml	2.5U	
Singh et al., 2014	Botox(OnabotulinumtoxinA) 5U/0.1mL	3U	
Suber et al., 2014	Botox(OnabotulinumtoxinA) 2U/0.1ml	4~6U	

GS, gummy smile

Table 4. Summary of BoNT injection technique in the treatment of excessive gingival display

Study	Target muscle		Injection point	Determination of injection point
Polo, 2005	LLSAN, LLS, ZM, DSN		2 or 3point	EMG
Kim et al., 2006	LLSAN, LLS		2point	EMG
Polo, 2008	LLSAN, LLS, ZM		2point	Manual*
Hwang et al., 2009	LLSAN, LLS, ZM		1point	Yonsei point*
Gracco and Tracey, 2010	LLSAN,LLS,ZM		1point	10mm lateral to and 5mm inferior to the nasal ala
Mazzuco and Hexsel, 2010	Anterior GS	LLSAN	1point	1 cm lateral and below the nasal ala
	Posterior GS	ZM, Zmi	2point	2 injection point*
	Mixed GS	LLSAN, ZM, Zmi	3point	Both anterior GS and posterior GS injection points
	Asymmetric GS	ZM, Zmi	2point	Posterior GS injection points
Sucupira and Abramovitz, 2012	LLSAN		1point	3 to 5mm lateral to the nostril
Dinker et al., 2013	LLSAN, LLS, ZM		2point	Manual*
Singh et al., 2014	LLSAN, DSN		2point	EMG
Suber et al., 2014	LLSAN, LLS		3point	3 injection point *

GS, gummy smile; LLSAN, levator labii superioris alaque nasi; LLS, levator labii superioris; ZM, zygomaticus major; Zmi, zygomaticus minor; DSN, depressor setpi nasi; Yonsei point *, 1cm lateral to the ala horizontally and 3cm above the lip line vertically; EMG, electromyographic guidance; Manual*, determined by muscle animation(smiling) and palpation on contraction; 2 injection point * : (1) nasolabial fold, at the point of greatest lateral contraction during the smile (2) 2 cm lateral to the first point, at the level of the tragus; 3 injection point * : (1) 2mm lateral to the alar-facial groove (2) 2mm lateral to the first injection (3) 2mm inferior and between the first 2mm sites

Table 5. Summary of outcomes in the treatment of excessive gingival display

Study	Pre- treatment gingival exposure (mm)		Post- treatment gingival exposure (mm)	Improvement percentage (%)
Polo, 2005	4.2mm		0mm	None
Kim et al., 2006	6.7mm		1.7mm	75% at 4(W)
Polo, 2008	5.2mm		0.09mm	98% at 2(W)
Hwang et al., 2009	GS	5mm	2mm	None
	Asymmetric GS	4mm	Symmetric smile	None
Gracco and Tracey, 2010	Case 1	None	None	None
	Case 2	6mm	0mm	None
	Case 3	4.5mm	0mm	None
Mazzuco and Hexsel, 2010	Anterior GS	None	None	96% at 20~30 days
	Posterior GS	None	None	61.1% at 20~30 days
	Mixed gummy GS	None	None	90.1% at 20~30 days
	Asymmetric GS	None	None	71.9% at 20~30 days
Sucupira and Abramovitz, 2012	3.62mm		0.58mm	84% at 2(W)
Dinker et al., 2013	Posed	4~5mm	None	None
	Unposed	8~10mm	None	None
Singh et al., 2014	4mm		0.8mm	80% at 2(W)
Suber et al., 2014	Central incisor	4.89mm	0.75mm	85% at 2(W)
	Canine	4.25mm	0.74mm	

GS, gummy smile; (W), weeks

Table 5. (continued)

Study	Satisfaction evaluation		Short term adverse events	Treatment longevity (weeks)
Polo, 2005	None		None	12~24
Kim et al., 2006	None		None	16~24
Polo, 2008	Average patient satisfaction was 4.66 on a 5-point scale.		A little discomfort *	>24
Hwang et al., 2009	GS	None	None	20
	Asymmetric GS	None	None	None
Gracco and Tracey, 2010	None		None	None
Mazzuco and Hexsel, 2010	Anterior GS	None	None	12~20
	Posterior GS	None	None	12~20
	Mixed GS	None	One patient- slightly asymmetric smile, One patient- "sad smile"	12~20
	Asymmetric GS	None	None	12~20
Sucupira and Abramovitz, 2012	Average patient satisfaction was 9.75 on a 10-point scale.		Average pain was 1.74 on a 10-point scale.	>12
Dinker et al., 2013	None		None	None
Singh et al., 2014	Based on VAS assessment, all patients were pleased with the treatment results.		None	24
Suber et al., 2014	Based on 5-point scale, 13 of 14 particiants were satisified with their results.		None	12

GS, gummy smile; A little discomfort *, Eight subjects reported pain at injection sites and 4 subjects reported twitching at the injection site. One subject experienced headache and 1 subject experienced dizziness.

IV. DISCUSSION

It is said that aesthetic appearance of a smile is created by harmony between teeth, lip framework, and gingival scaffold (Garber and Salama, 1996). The lip framework is determined by the activity of various facial muscles, such as LLS, LLSAN, ZM/Zmi. Such muscle plays a role of lifting the upper lip and pulling it toward side when smiling and it creates smile through interaction with depressor septi nasi muscle, risorius, and orbicularis oris muscle (Figure 1). Although beautiful smile can be created when there is adequate interaction between muscles, excessive gingival display occurs when excessive muscle capacity is applied to lift upper lip.

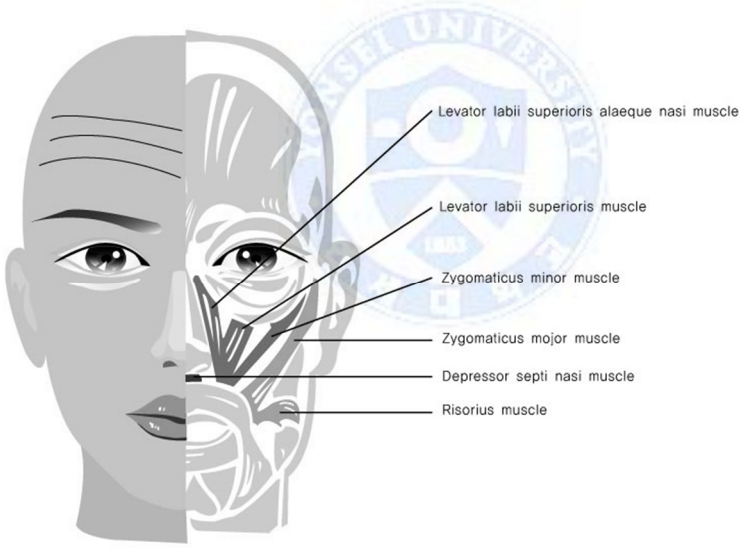

Figure 2. Main muscle involved in gingival exposure

The method to improve gummy smile through muscle hyperactivity can largely be divided into surgical and non-surgical method. Various methods have been introduced since Rubinstein and Kostianovsky (1973) have introduced their surgical method and as its limitation the discomfort and side effects followed by the surgery, relapse, and others have been proposed (Ellenbogen, 1984). In

regards to non-surgical method, Polo (2005) has introduced for the first time the method to inject BoNT to muscle around the lip. It has many advantages including less discomfort and side effects after the treatment and non-surgical method.

Although gummy smile treatment method using BoNT has advantages of being safe, reliable, and reversible, it was introduced relatively recently thus there are limitations in that there is not many literatures and research methods and treatment methods of each research differ vastly. Accordingly, the purpose of this review is to summarize research methods and treatment methods applied in each literature and provide roadmap for future studies.

Composition of patients

Age and gender

Looking into the treatment subject, most of treatment subject was women with wide range of age distribution from 15 to 48 excluding 4 papers which do not reveal sex or age of treatment subject. The fact that majority of gummy smile treatment subject is women can be understood when considering the study by Tian et al. (1984) which suggests that women are more interested in aesthetics compared to men and high smile is more dominant in women while low smile is more dominant in men. Also, the fact that treatment subject is young is meaningful. Niamtu (2008) suggested that satisfaction of gummy smile patients treated with BoNT was low and it was because the age of treatment subject was relatively old ranging from 35 to 60. In case of young adult, there is an increase in treatment satisfaction since they are more sensitive to aesthetics and have more tolerance to discomfort that generates from the treatment. On the other hand, in case of older people, there was an aggravation in discomfort and decrease in treatment satisfaction because decrease in muscle tone accompanied by aging process accelerated with the BoNT treatment. Therefore, it was

determined that there is a necessity to make distinction of age in future BoNT studies.

Smile pattern

Not only distinctions about patients' age but also smile pattern is necessary to acquire adequate treatment effect. Among searched papers, 1 paper has considered the smile type and selected cuspid smile patient was selected as a result (Suber et al. 2014). Rubin (1974) has classified the smile patterns into 3 including "Mona Lisa", "canine smile", "full denture smile". A "Mona Lisa" smile is dominated by the ZM muscle and depicted by sharply elevated corners. A "canine smile" is characterized by an elevation over the medial portion of the upper lip via a prominent levator labii superioris action. Last, a "full denture" smile is dominated by all of the upper retractor muscles in addition to the lower depressors, resulting in a smile that exposes all teeth. Kane (2003) observed that dissatisfied study participants in his BoNT study tended to be patients with a "Mona Lisa" or "full denture smile". Injections of BoNT further depresses upper lip elevation compared with the commissures, leading to a cartoonish smile in patients with a "Mona Lisa smile" or results in a grimace for patients with a "full denture smile". Therefore, it is determined that consideration on patient smile type in the future is necessary since understanding on smile type of patients can also increase the success rate of treatment using BoNT.

Measurement of gummy smile

Maximal smiling

In regards to the measurement of excessive gingival exposure, one of the criteria to determine treatment effect, the measurement method varied for each researcher thus there was controversy in examining the treatment effect. The

acquisition of “maximum smile” or “unposed smile” before and after the treatment is an important criteria to examine the treatment effect. Since the patients receiving the treatment know that the goal of treatment is to show less gum, they may not present maximum smiling for post-treatment smile photo either intentionally or unintentionally different from that of pre-treatment. Therefore, there is a possibility that the treatment effect may be distorted. Such fact can be examined from the comment of Niamtu (2008) regarding the BoNT study by Polo (2005). Therefore, additional effort is necessary to acquire maximum smiling and such effort was presented in 3 among 10 papers. Two literature described that the maximum smile of patients was promoted through funny joke or statement and 1 literature suggested that there is an emergence of maximum smile when there is an expression of eye such as squint. As it was mentioned by Niamtu (2008), the only reliable means of controlling smile dynamics would be to accurately stimulate the individual muscles with electrical current (before and after the treatment) with needle electrodes; this would result in controlled, precise, and repeatable contractions. Obviously, this would be a painful situation and almost impossible to duplicate in an awake and conscious patient in the upright position. Therefore, in order to secure the objectivity of gingival exposure quantity before and after the treatment in future studies, study should be conducted with the effort to induce maximum smile.

Measurement of gingival exposure

Method to measure the degree of gingival exposure is as important an item as maximal smiling induction. Eight among 10 papers described about methods to measure the degree of gingival exposure. Five papers measured the degree of gingival exposure through photography, Polo (2008) used photography and video together, and Gracco and Tracey (2008) took a video. Suber et al (2014) conducted 4 repeated measurement with the use of standardized measuring tape without taking photo and it was because the moment of maximal smile

emergence cannot accurately be taken with a photo. As it was mentioned by Suber et al (2014), it is difficult to capture maximal smile from single moment of time. Therefore, maximal smile screenshots acquired from video can be used as more objective data compared to photography. Also, the studies by Mazzuco and Hexsel (2010) and Polo (2005), the effort was made to narrow down the error between before and after treatment using computer program or reference point to compensate the error that generates from photography at the same environment. It would also be an item to be considered when conducting studies in the future.

BoNT

Product and preparation

Nine papers from this literature review used onabotulinumtoxinA (Botox, Allergan, Irvine, California) and 1 paper used abobotulinumtoxinA (Dysport, Ipsen Biopharm Limited, Wrexham, UK). Considering the fact that standard conversion rate of abobotulinumtoxinA and onabotulinumtoxinA is 2.5 U:1 U in a study by Karsai and Raulin (2009), the dose of BoNT in Mazzuco and Hexsel (2010) using abobotulinumtoxinA of 2.5−7.5 U can be considered as comparable with the dose of 9 other papers which used onabotulinumtoxinA of 1.95−6 U. Since the BoNT of similar dose was used, onabotulinumtoxinA and abobotulinumtoxinA presented similar improvement effect. However, since abobotulinumtoxinA presents greater efficacy and longer duration of effect, there is an increase in possibility of side effects (Simonetta et al., 2003). Also considering the fact that onabotulinumtoxinA is spreading to relatively safe and small area compared to abobotulinumtoxinA, it can be determined that onabotulinumtoxinA is more adequate to be used for facial expression muscle treatment. Therefore, comparative studies between onabotulinumtoxinA and abobotulinumtoxinA would have significance in future studies.

Used dosage per side

Looking into the dose of BoNT presented in 10 literatures, it was observed to vary from 1.95–6.25 U but low dose or high dose was both effective in the treatment. Garcia and Fulton (1996) showed that low dose injection of BoNT per muscle (2–5 IU) was as effective as higher doses. Kane (2003) treated excessive gingival display through improvement of the nasolabial fold, targeting the LLSAN with 5 U per side. The injection dose was 1 U initially; at 2 to 3 weeks' follow–up, the subsequent dose was determined according to clinical response. This is a good and cautious approach that helps to prevent undesirable side effects related to excessive doses or excessive potency of the selected dose for a specific patient. Polo (2013) advised that the dose and injection sites of BoNT should be tailored to the severity of gingival display: 1 injection site and 2 U per side when the gum exposure is inferior 4~5 mm, 1 injection site and 2.5U per side when the gingival exposure is 5~7mm, 2 injection sites and 2.5U injection when it exceeds 7 mm. Therefore, in order to treat gummy smile, the method to inject different amount based on the quantity of gummy smile rather than injecting fixed amount is necessary. At the moment, the method to inject small amount first and then inject some more through retouching when necessary is determined to be more adequate as a safe approach method.

Injection technique

Target muscles

In 10 papers, LLSAN is consistently injected muscle. The LLSAN originates from the frontal process of the maxilla and inserts into the upper lip and the skin tissue or the ala of the nose (Fehrenbach and Herring, 2002). From the studies by Sucupira and Abramovitz (2012) and Mazzuco and Hexsel (2010) which injected BoNT to LLSAN muscle only, the improvement quantity of gummy smile was 84% and 96%. From the study by Mazzuco and Hexsel (2010) which injected BoNT in ZM and Zmi muscle excluding LLSAN, the improvement

quantity of gummy smile was 61.1% and 71.9%. This entails that LLSAN is an important target muscle in BoNT injection. As it was mentioned in the study by Mazzuco and Hexsel (2010), however, the improvement in posterior gummy smile maybe difficult with LLSAN injection only as it receives more influence from zygomaticus muscles thus it is difficult to consider LLSAN as an essential muscle in gummy smile treatment.

Injection point

In order to inject BoNT to muscles (LLS, ZM, Zmi, DSN) other than LLSAN, number of points was diversified from 1 to 3 point in each paper. Increasing the number of injection points does not seem to lead to an improved outcome. Sucupira and Abramovitz (2012) reported the improvement quantity of 84% with 1 point injection and Polo (2008) reported the improvement quantity of 98% with 2 point injection. Suber et al (2014) reported the improvement quantity of 85% by conducting 3 point injection. Of course such phenomenon may come from the fact that there is a difference in the quantity of gummy smile before treatment and number of samples between each paper. Therefore, it is necessary to conduct studies on relation between the number of points and improvement quantity of gummy smile in the future.

Determination of injection point

Method to locate injection point was observed differently in each paper. Three papers used electromyography, 2 papers pinpointed the location by feeling the contraction of muscle while smiling with the use of fingers and 5 papers used the method to conduct injection to certain distance from particular landmark. In order to pinpoint accurate location of muscle, it is of great assistance to use electromyography (Pessa et al., 1998, Klein and Mantell, 1998) but the use of electromyography has limitation that it brings about pain and inconvenience. Considering the fact that BoNT spreads 1~2cm from the point, method to use

landmark can be considered as effective. Relevant to such point, Hwang et al. (2009) proposed "Yonsei point" which can deliver BoNT to LLSAN, LLS, and Zmi with 1 point injection through cadaver study. This landmark was identified as the center of a triangle formed by the convergence of the LLSAN, the LLS, and the Zmi muscles and is located 1 cm lateral to the ala horizontally and 3 cm above the lip line vertically in both men and women.

Treatment outcomes

Longevity

Looking into the treatment longevity, the most of studies reported the treatment effect of 12 up to 20 weeks. Polo (2008) noted that the average gingival show had still not returned to baseline values at 24 weeks post-injection. Mazzuco and Hexsel (2010) demonstrated that there is prolonged reduction of gingival exposure following several injections of BoNT. It is determined that such phenomenon occurs due to reduction in muscle volume and contraction capacity followed by temporary paralysis even if BoNT effect disappears.

Short term adverse events

Although most of patients expressed satisfaction toward the treatment in treatment result assessment, short-term discomfort was observed from some patients. Although some patients expressed discomfort at the time of injection insertion and some expressed headache and dizziness after the injection in the study by Polo (2008), it was mostly a temporary symptom and recovery of symptom was observed within several days. In the study by Mazzuco and Hexsel (2010), slightly asymmetric smile and sad smile were observed and such discomfort was improved with additional injection. Although such discomfort is temporary phenomenon and it can easily be improved through retouching in follow-up period, side effects that last for several months are observed from

some patients (Carruthers and Carruthers, 2004; Niamtu 2008). Therefore, Niamtu (2008) and Ahn et al. (2013) asserted that BoNT injection should be conducted by highly experienced practitioners only.

There are several limitations to this review. Since BoNT treatment was introduced relatively recently, there are limitations in that there are small number of research papers and all of them had small sample sizes. Also, there exists the difference in treatment method and treatment subject between researchers thus comparison between each study is difficult. In addition, the lack of a randomized controlled trial prevented us from performing a traditional meta-analysis and limited our systematic review to a form of pooled analysis.

V. CONCLUSION

The purpose of this study was to review the studies on treatment of gummy smile using BoNT injection. For gummy smile treatment, BoNT injection is non-surgical, reversible, and effective treatment method. As a result of literature review, LLSAN muscle was revealed to be most important muscle in gummy smile treatment and there are LLS, ZM, Zmi, and DSN as other important muscles. Both low and high dose of BoNT presented gummy smile improvement effect. Since high dose of botulinum injection could induce adverse effect, it is adequate to take safe approach method where low dose is injected first and inject some more as retouching when necessary. Also, it was revealed that the side effects followed by BoNT injection is temporary and treatment effect lasts for at least 12 weeks. Since this paper has some limitations, I believe that clinically significant result could be acquired when future adequately designed and randomized controlled trials are conducted.

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국문요약

보툴리눔 독소를 이용한 치은과다노출증의 치료

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미소시 2mm 이상 치은이 노출되는 치은과다노출증은 비심미적으로 인식된다. 치은과다노출증의 발생원인은 치아의 지연맹출, 상악골의 수직성장, 상순의 과운동성, 짧은 상순에 의해 발생되는데, 발생 원인에 따라 보철적 치료, 교정적 치료, 수술적 치료를 이용할 수 있다.

최근 비수술적 방법으로 보툴리눔독소를 이용한 치은 과다노출증의 치료법이 소개되었는데, 치료방법이 아직 표준화되지 않은 관계로, 치료 방법이나 치료 효과에 대한 논란의 여지가 있다. 이에 본 연구에서는 문헌고찰을 통하여, 치은과다노출증 치료방법으로서 보툴리눔독소의 역할과 향후 보툴리눔독소를 이용한 치은과다노출증의 연구시 연구지침을 알아보고자 하였다.

2015 년 4 월 1 일 기준으로 Pubmed, Scopus, Web of science 에서 온라인 문헌검색을 시행하였다. 검색에 사용한 키워드는 gummy smile 혹은 gingival exposure 혹은 gingival display 와 botox 혹은 botulinum 혹은 onabotulinumtoxinA 혹은 abobotulinumtoxinA 의 조합으로 하였다.

문헌 검색결과 33 개의 문헌이 검색되었고, 이 중 기준에 맞지 않은 23 개의 문헌을 제외한 10 개의 논문을 이번 연구에 이용하였다.

문헌고찰 결과 치은과다노출증의 보툴리눔독소 치료법은 가역적이며 효과적인 치료방법이고, 보툴리눔독소 주입시 발생하는 부작용은 작고 일시적이며, 치료에 대한 환자의 만족도가 높고, 치료 효과는 최소 12 주 이상 지속됨을 알 수 있었다. 이 논문은

몇몇 한계점을 가지고 있기 때문에 향후 잘 디자인 된 무작위 비교연구를 시행한다면, 임상적으로 의미 있는 결과를 얻을 수 있을 것으로 판단된다.

핵심되는 말: 과다치은 노출, 보툴리눔 독소